Chapter 1
Introduction

1-1. Purpose

This manual presents procedures for the design analysis and criteria of design for improved channels that carry rapid and/or tranquil flows.

1-2. Scope

Procedures are presented without details of the theory of the hydraulics involved since these details can be found in any of various hydraulic textbooks and publications available to the design engineer. Theories and procedures in design, such as flow in curved channels, flow at bridge piers, flow at confluences, and side drainage inlet structures, that are not covered fully in textbooks are discussed in detail with the aid of Hydraulic Design Criteria (HDC) charts published by the US Army Engineer Waterways Experiment Station (USAEWES). The charts and other illustrations are included in Appendix B to aid the designer. References to HDC are by HDC chart number. The use of models to develop and verify design details is discussed briefly. Typical calculations are presented to illustrate the principles of design for channels under various conditions of flow. Electronic computer programming techniques are not treated in this manual. However, most of the basic hydraulics presented herein can be adapted for computer use as illustrated in Appendix D.

1-3. References

References are listed in Appendix A.

1-4. Explanation of Terms

Abbreviations used in this manual are explained in the Notation (Appendix I). The symbols employed herein conform to the American Standard Letter Symbols for Hydraulics (American Society of Mechanical Engineers 1958) with only minor exceptions.

1-5. Channel Classification

In this manual, flood control channels are considered under two broad classifications: rapid- and tranquil-flow channels. The most important characteristics that apply to rapid and tranquil flows are listed below:

a. Velocities. Rapid flows have supercritical velocities with Froude numbers greater than 1 ($F > 1$), and tranquil flows have subcritical velocities with Froude numbers less than 1 ($F < 1$).

b. Slopes. Invert slopes in general are greater than critical slopes ($S_o > S_c$) for rapid flow and less than critical slopes ($S_o < S_c$) for tranquil flow.

c. Channel storage. Channel storage is usually negligible in rapid flow, whereas it may be appreciable in natural rivers with tranquil flow.

d. Discharge. All discharges are normally confined within the channel for rapid flow (no overbank flow).

Other characteristics such as standing waves, surges, and bed configuration that differ under the influence of rapid- or tranquil-flow conditions should be recognized and considered as the occasion demands. Rapid and tranquil flows can occur within a longitudinal reach of a channel with changes in discharge, roughness, cross section, or slope. Channel improvements may bring about changes in flow characteristics.

1-6. Preliminary Investigations for Selection of Type of Improvement

The investigation required in selecting the type of channel improvement to be adopted involves three considerations: physical features of the area, hydraulic and hydrologic aspects, and economy.

a. Physical features. The topography of the area controls in a general way the channel alignment and invert grades. Of prime importance, also, are width of available right-of-way; location of existing channel; and adjacent existing structures, such as bridges, buildings, transportation facilities, utility structures, and outlets for local drainage and tributaries. Invert slopes may be controlled by elevations of existing structures as well as by general topography, elevations at ends of improvements, and hydraulic features.

b. Historical and observed elements. The flow characteristics noted in historical records and indicated from detailed observation of existing conditions will usually be basic to the selection of type of improvement or design. With the flood discharges determined, the interdependent factors that determine improvement methods and general channel alignment are slope of invert, width and depth of flow, roughness coefficient, the presence or nature of aggradation and degradation processes, debris transportation, bank erosion, cutoffs, and bar formations.

c. Preliminary layout. A preliminary map or aerial mosaic of the area showing the topography and other control factors to a scale satisfactory for plotting the center line of the channel should be obtained. A scale of 1 inch (in.) to 100 feet (ft) with 2-ft-contour interval is suggested, although judgment based on local conditions should be used. A preliminary profile should be prepared that will show all pertinent elevations of the ground and existing structures along the banks and along the center line of the proposed channel.

d. Preliminary alternative designs. From a study of the preliminary plan, profiles, and available widths, tentative channel cross sections are adopted. These are generally rectangular or trapezoidal sections. Low velocity flows can usually be carried in natural-bottom trapezoidal channels with or without stone-revetted side slopes. High- velocity flows normally would be carried in concrete-lined channels. Preliminary hydraulic analyses of the proposed channels are then made with a view toward establishing the most efficient channel improvement from the standpoint of hydraulic efficiency and economic feasibility.

e. Economy. Approximate cost estimates are prepared, including costs of channel construction, appurtenant works and bridges, and rights-of-way. It may be necessary to consider several channel alignments, cross sections, and construction materials before the least-cost design consistent with sound engineering principles is determined. Assured performance, consistent with project formulation based on sound engineering judgment, is a necessary part of economic consideration. With an optimum general design thus tentatively established, and provided the cost is economically feasible for the project as a whole, the detailed hydraulic design is presented in Chapter 2.